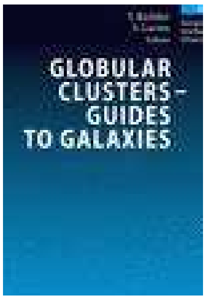
LIGHTHOUSES OF THE UNIVERSE: THE MOST LUMINOUS CELESTIAL OBJECTS AND THEIR USE FOR COSMOLOGY
ESO Astrophysics Symposia, 2002, 2002, 304-306, DOI: 10.1007/10856495_47



X-Ray Variability of Blazar PKS 2155-304: Probing the Dynamics of the Jet

You Hong Zhang, Aldo Treves, Annalisa Celotti, Lucio Chiappetti, Giovanni Fossati, Gabriele Ghisellini, Laura Maraschi, Elena Pian, Gianpiero Tagliaferri and Fabrizio Tavecchio

Abstract

We present temporal and spectral analysis of the X-ray bright blazar PKS 2155-304 observed with *Beppo*SAX. Power density spectra show strong red noise feature with steep slope of $\sim 2-3$. Structure functions suggest typical timescale of ~ 0.5 days. Inter-band time lags differ from flare to flare. Peak energies of synchrotron component increase with increasing flux, and complexities of spectral evolution are detected. The implications of our results are discussed in the context of synchrotron cooling model of relativistic electrons accelerated through internal shocks taking place in the jet.

Fulltext Preview

X-Ray Variability of Blazar PKS 2155–304: Probing the Dynamics of the Jet

You Hong Zhang[1], Aldo Treves[1], Annalisa Celotti[2], Lucio Chiappetti[3], Giovanni Fossati[4], Gabriele Ghisellini[5], Laura Maraschi[6], Elena Pian[7], Gianpiero Tagliaferri[5], and Fabrizio Tavecchio[6]

[1] Università dell'Insubria, via Valleggio 11, I-22100 Como, Italy
[2] SISSA/ISAS, via Beirut 2-4, I-34014 Trieste, Italy
[3] IFCTR/CNR, via Bassini 15, I-20133 Milano, Italy
[4] CASS, UCSD, 9500 Gilman Drive, La Jolla, CA 92093-0424, USA
[5] OAB, via Bianchi 46, I-22055 Merate, Italy
[6] OAB, via Brera 28, I-20121 Milano, Italy
[7] OAT, via G.B.Tiepolo 11, I-34131 Trieste, Italy

Abstract. We present temporal and spectral analysis of the X-ray bright blazar PKS 2155–304 observed with *Beppo*SAX. Power density spectra show strong red noise feature with steep slope of ~ 2–3. Structure functions suggest typical timescale of ~ 0.5 days. Inter-band time lags differ from flare to flare. Peak energies of synchrotron component increase with increasing flux, and complexities of spectral evolution are detected. The implications of our results are discussed in the context of synchrotron cooling model of relativistic electrons accelerated through internal shocks taking place in the jet.

1 X-Ray Variability

PKS 2155-304 was monitored with *Beppo*SAX in November of 1996, 1997 and 1999, with ~ 2 days pointing each time. Light curves for 1996 and 1997 have been presented in [1]. We show in Figure 1 (left panel) the light curve for 1999. The source underwent different brightness changes and showed significant variations with recurrent flares detected.

We calculate the normalized power density spectrum (NPDS) utilizing the standard discrete Fourier transform. Each NPDS generally shows quick decrease of power with increasing frequency and can be fitted with a power-law model ($P(f) \propto f^{-\alpha}$). The behavior of strong *red noise* variability is indicated by the steep slope ranging from ~ 2 to 3. We also calculate the first order Structure Function (SF). One example is shown in Figure 1 (right panel) derived from the 2–10 keV light curve of 1999. The most powerful ability of SF is to estimate the characteristic τ_c, identified as the timescale where the first "turn-over" of the SF occurs. To do so, we fit the SF with a broken power-law model. One example of this fitting is also shown in the same figure as SF.

Cross-correlation analysis using two techniques suited to unevenly sampled time series, the Discrete Correlation Function (DCF) and the Modified Mean Deviation (MMD), are performed to evaluate the degree of correlation and inter-band time lags of variations. The results show that soft lag (lower energy photons lagging higher energy ones) of the source differs from flare to flare, ranging from a few hundred seconds to one

ESO Symposia: Lighthouses of the Universe, pp. 304–306, 2002.